DAVID BLOOM

Late Precambrian tectonism in the Kingston Range, southern California

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ABSTRACT

Speculation on the early history of the Cordilleran geosyncline of North America has relied in part on interpretation of the tectonic setting of the Precambrian Pahrump Group. Recent mapping in the Kingston Range resulted in new data to aid our speculation. Specifically, Precambrian tectonic events involving folding and later low-angle normal faulting affected the Crystal Spring Formation, Beck Spring Dolomite, and lower part of the Kingston Peak Formation. Unconformably overlying these units is a relatively undeformed conglomerate. Diamictite occurs both above and below the unconformity; hence, Cordilleran-wide correlations of the Kingston Peak Formation based on diamictite require reassessment.

The nature of boundaries, localized deformation, and outcrop distribution of the Pahrump Group suggest that these rocks may be preserved in transtensional basins associated with strike-slip faulting, possibly occurring during development of the late Precambrian continental margin.

INTRODUCTION

The initiation of the Cordilleran geosyncline has long been a topic of speculation, especially regarding the paleogeography of the margin and the timing and tectonic process involved in its initiation (Stewart, 1972). Initial rifting was thought to have occurred during "Beltian" time (ca. 1400 Ma; Burke and Dewey, 1973; Burchfiel and Davis, 1972) and miogeoclinal sedimentation to have begun with deposition of late Precambrian diamictite units (Stewart, 1972). Recent work suggests that full separation may not have occurred until late Proterozoic or Early Cambrian (545–600 Ma; Bond and Kominz, 1984; Armin and Mayer, 1983).

In southeastern California, Precambrian sedimentary rocks of the Pahrump Group are the stratigraphic record of events between Hudsonian deformation (1.6–1.8 Ga) and establishment of the late Precambrian to Paleozoic Cordilleran miogeocline. Our recent mapping in the Kingston Range reveals episodes of intra-Pahrump folding and normal faulting that are followed by deposition of conglomerate and miogeoclinal strata. The aims of this paper are to document this deformation and explore regional correlations based on this new information. These correlations and the distribution of compressional and extensional events that affected these rocks suggest that the early development of the Precambrian margin of western North America may have been controlled by strike-slip tectonics, as opposed to continental rifting of the East African type.

STRATIGRAPHY OF THE KINGSTON PEAK FORMATION

Hewett (1940) defined the Pahrump Group as consisting of the Crystal Spring Formation, Beck Spring Dolomite, and Kingston Peak Formation; much of our present understanding of these rocks results from the work of Wright and Troxel (1966) and Wright et al. (1974). Stratigraphy of the Crystal Spring Formation has been described by Roberts (1982) and that of the Kingston Peak Formation by Miller (1982, 1983). The lower part of the Kingston Peak Formation consists of basal bedded siltstone overlain by diamictite, fine-grained sandstone and argillite, in turn succeeded by interbedded diamictite, sandstone, and algal dolomite (Wright et al., 1974). In the Kingston Range, we interpret blocks of Beck Spring Dolomite and Crystal Spring Formation, which rest on deformed lower Kingston Peak, to be tectonically emplaced, and we include them in the lower Kingston Peak Formation in this discussion. Wright et al. (1974), ascribed emplacement of the large blocks to sedimentary processes. The upper Kingston Peak Formation locally lies unconformably on lower Kingston Peak and consists of conglomerate with minor diamictite. Stratigraphy of the Kingston Peak Formation in the Kingston Range is laterally variable: around Jupiter Peak (Peak 5177 in Fig. 1) only the uppermost part of the Kingston Peak Formation is present (above brecciated Beck Spring) and is extremely thin; in the southern part of the area, lower Kingston Peak Formation is present. Thus, the depositional edge of the Kingston Peak basin is present, although not exposed, in the map area.

The origin of diamictite in the Kingston Peak Formation has received much attention. Our work in the Kingston Range suggests that diamictite is resedimented conglomerate because of the common occurrence of slump folds, soft-sediment deformation, and presence of graded beds (turbidites). A similar interpretation was presented by Wright et al. (1974). Features indicative of glacial origin were not recognized in the study area, although Miller (1982, 1983) reported dropstones and glacial striae elsewhere. Clasts in the Kingston Peak consist of Beck Spring Dolomite, granite, diabase, and Crystal Spring Formation. Large clasts (hundreds of metres long) and olistostromes are

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also present in the lower Kingston Peak and have depositional boundaries. Slump folds and olistostromes suggest that tectonic relief in the area, rather than glaciers, may have caused debris flows and megaclasts to be deposited in the Kingston Peak basin.

STRUCTURE OF THE KINGSTON RANGE AREA

The configuration of units in the northeastern Kingston Range results from Tertiary normal faulting, Precambrian normal faulting, and Precambrian folding (Fig. 1). Our mapping reveals that Precambrian deformation occurred between deposition of the lower and upper parts of the Kingston Peak Formation; the lower part and the Crystal Spring Formation and Beck Spring Dolomite were folded and developed pressure solution and recrystalliza-

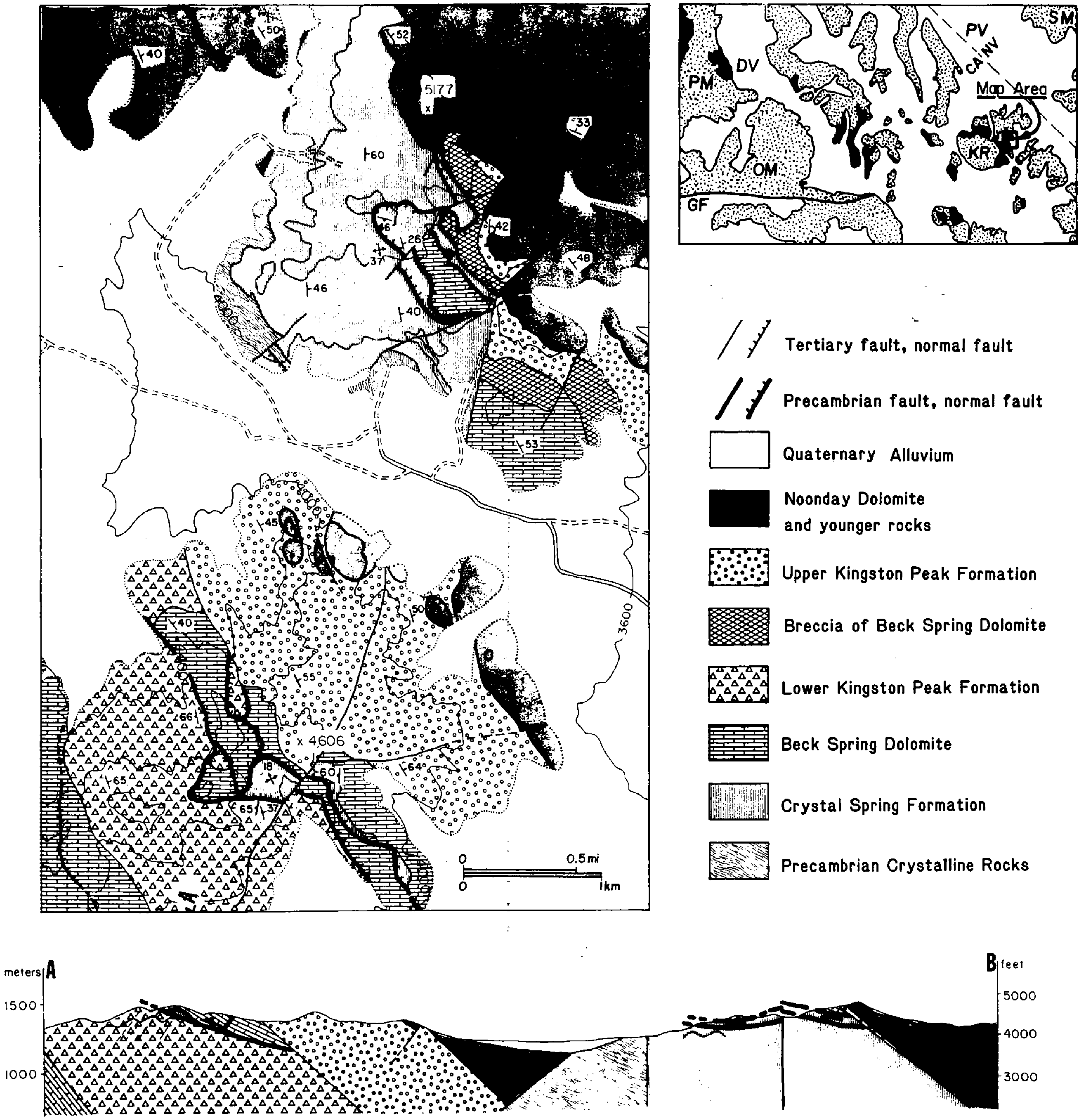

Figure 1. Geologic map and regional location map of study area. Black areas on location map indicate outcrops of Pahrump Group. PM = Panamint Mountains, DV = Death Valley, GF = Garlock fault, OM = Owlshead Mountains, SM = Spring Mountains, PV = Pahrump Valley, KR = Kingston Range. Folding (wavy lines within units) is drawn approximately to scale; light dashed lines indicate cleavage. Precambrian unconformity, which truncates normal faults, occurs at base of upper Kingston Peak Formation. Lower Kingston Peak Formation is present locally in northern part of map area but is not differentiated on geologic map.

tion cleavage, and were then cut by normal faults prior to deposition of the upper part of the Kingston Peak Formation. The northern part of the area was mapped at a scale of 1:21 000 and the southern part at 1:8000 on photoenlargements of the Horsethief Spring and Kingston Peak quadrangle topographic base maps.

The oldest structures recognized are folds that deform the Crystal Spring Formation, Beck Spring Dolomite, and lower Kingston Peak Formation. Folds with wavelengths of 1 to 200 m are locally tight to isoclinal and have cleavage and fissility subparallel to northwest-trending axial surfaces (Fig. 2). Cleavage is present only in units below the upper Kingston Peak Formation and is widely developed south of Jupiter Peak (Peak 5177) and southwest of Peak 4606 (Fig. 1). The widespread distribution of this cleavage, reprecipitation textures in thin sections, and its systematic high angle to bedding point to tectonism as opposed to mechanical rotation of grains during localized compaction (Tobish, 1984). Additional fold phases are developed near the Precambrian fault surfaces around Peak 4606. In the hanging wall of a normal fault block, a transposition foliation that commonly trends north-northwest is locally developed in silty limestone beds of the Beck Spring Dolomite at the base of the block. Transposition surfaces are folded in open, angular folds with northwest-trending, moderately northeast-dipping axial surfaces.

In the southern part of the map area, large blocks of Beck Spring Dolomite and Crystal Spring Formation are faulted onto the lower Kingston Peak Formation (Fig. 1). The fault is a bleached crush zone that cuts folded units in the footwall and hanging wall and is itself folded. West of Jupiter Peak, folds are cut by normal faults with slip zones defined by well-developed fissility which is superposed on a fissility associated with the folding. Precambrian normal faults, in their present geometry, commonly place older rocks on younger rocks; however, beds adjacent to and caught up in the faults are extended and do not overlap.

Precambrian folds and normal faults are dated by overlap of the upper Kingston Peak conglomerate near Peak 4606. West of Jupiter Peak, the upper Kingston Peak Formation and lower Noonday Dolomite are cut by a steep normal fault that is apparently unconformably overlain by upper Noonday Dolomite.

The most conspicuous structures in the area are Tertiary normal faults and associated northeast-trending high-angle faults (Burchfiel et al., 1983), which account for the regional eastward dip of the strata. Normal faults and high-angle faults cut Tertiary limestone and volcanic rocks that yield an isotopic date of 12.5 ±0.13 Ma (K/Ar, J. Spencer, 1983, personal commun.). This sequence is overlapped by undeformed younger Tertiary volcanic rocks and recent alluvial material (Burchfiel et al., 1983).

AGE AND REGIONAL CORRELATION OF PRECAMBRIAN EVENTS

The age of the Pahrump Group is not well constrained. The group is younger than 1400 Ma based on the age of granite intrusion into earlier Precambrian basement in Death Valley (Labotka and Albee, 1977). The Crystal Spring Formation is intruded by diabase sills that have been correlated with sills in Arizona that intrude the Apache and Unkar Groups (Wrucke, 1972; Spall and Troxell, 1974; Labotka and Albee, 1977; Hammond, 1982; Shride, 1967). Sills in the Unkar have been dated at 1070 ±30 Ma (Rb/Sr; Elston and McKee, 1982), and possible cogenetic lava at the top of the Unkar yields a similar age of 1070 ±70 Ma (Rb/Sr; McKee and Noble, 1974). If these units correlate with those in the Death Valley area, the Crystal Spring Formation is older than 1070 Ma. The Kingston Peak Formation is younger because it contains debris of both Crystal Spring and diabase. The Pahrump Group is overlain by the upper Precambrian Noonday Dolomite, which is probably younger than about 650 Ma (Stewart and Suczek, 1977).

Regional correlation of the Kingston Peak Formation depends on which features we wish to emphasize. Three features stand out: the diamictite in the lower Kingston Peak Formation; conglomerate and diamictite in the upper Kingston Peak; and the deformational events within the Kingston Peak Formation. The lower Kingston Peak Formation may correlate with diamictite at the base of the Windermere sequence (Stewart, 1972), but this correlation requires deformational events that include folding and low-angle faulting during Windermere time, or only a local extent of the mid–Kingston Peak unconformity. Alternatively, the upper Kingston Peak Formation may correlate with the basal Windermere.

Deformation within the Kingston Peak Formation may correlate with an intra–Kingston Peak unconformity reported in the Panamint Range (Miller, 1983). Diamictite in the upper Kingston Peak Formation in the Panamints is interbedded with Noonday Dolomite (Miller, 1983). Regionally, the deformational event may also correlate with the Grand Canyon disturbance at the top of the Chuar Group, and possibly with the Goat River orogeny in southern British Columbia (McMechan and Price, 1982). Further dating of rocks in the Pahrump Group must be completed before reliable correlations can be made.

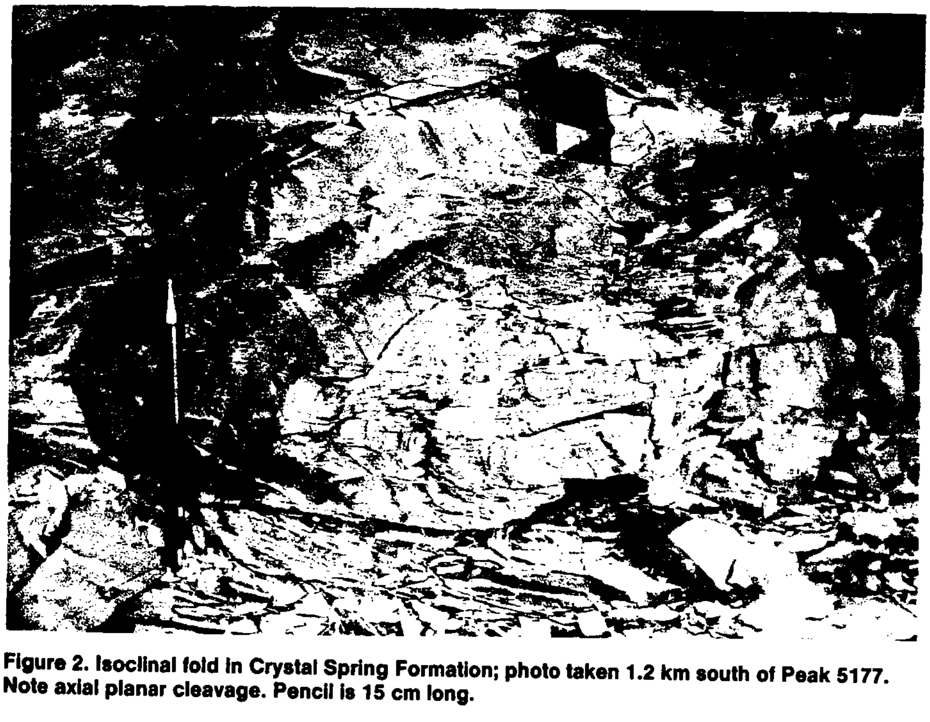

Figure 2. Isoclinal fold in Crystal Spring Formation; photo taken 1.2 km south of Peak 5177. Note axial planar cleavage. Pencil is 15 cm long.

PRECAMBRIAN TECTONIC ENVIRONMENT

Construction of the Kingston Peak basin has been related to the rifting of the North American Pacific margin. Wright et al. (1974) interpreted Pahrump Group deposition to have occurred in a long-lived aulacogen and, along with Stewart and Suczek (1977), suggested that the Crystal Spring and Beck Spring Formations were once more extensive deposits preserved in a trough created during Kingston Peak deposition. The abrupt termination of Crystal Spring and Beck Spring units against Precambrian crystalline rock in the Kingston Range supports this conclusion. Rapid changes in thickness, and distribution of stratigraphy and source terrains of sediments in the Crystal Spring Formation outlined by Roberts (1982) also suggest that the Crystal Spring Formation and Beck Spring Dolomite accumulated in an intracratonal basin that significantly preceded or was unrelated to late Precambrian rifting.

The outcrop distribution of the Kingston Peak Formation in a pre-Tertiary reference frame (Stewart, 1983; Burchfiel et al., 1983) is a narrow north-northwest–trending belt. The creation of the Kingston Peak basin was followed by compressional deformation that produced folds and cleaved rocks, and later extension and normal faults. The trend, tectonic history, and sedimentation of this basin are best accounted for by Precambrian transcurrent tectonic activity (possibly similar to faulting in Canada; Eisbacher, 1981, p. 20). Tectonism has been reported during deposition of other late Precambrian sequences (e.g., Eisbacher, 1981); McMechan and Price; 1982; Link, 1983) and may be similar to events affecting the Kingston Peak basin. At any rate, the presence of folded and cleaved rocks in the Pahrump Group indicates that models invoking simple but protracted rifting as a tectonic environment need to be reexamined.

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